

	SURFACE VEHICLE STANDARD	SAE J1063 JUN2013
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		Superseding J1063 NOV1993
Cantilevered Boom Crane Structures - Method of Test		

RATIONALE

This revision will provide editorial corrections to the latest published version and changes the application requirements of SAE Test 5. Additionally, a test requirement to strain gage test the maximum rated load for jib / fly attachments is being added.

1. SCOPE

This SAE Standard applies to mobile, construction-type lifting cranes of the cantilever boom type (Figure 1). Questions and comments regarding application or interpretation of the provisions in this test method should be referred to the originating SAE Committee.¹

1.1 Purpose

The purpose of this test method is to provide a systematic, nondestructive procedure for determining the stresses induced in cantilevered boom crane structures under specified conditions of static loading through use of resistance-type electric strain gages, and to specify appropriate stress levels for specified loading conditions. Further, a 25% overload test is included to prove the overall structural integrity of the structure.

¹Chairman, Subcommittee SC31, ORMTC, Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

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2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE, ASTM, or other mentioned publications shall apply.

2.1.1 ASTM Publication

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org

ASTM E 251 Standard Test Methods For Performance Characteristics of Metallic Bonded Resistance Strain Gages

2.2 Other Publications

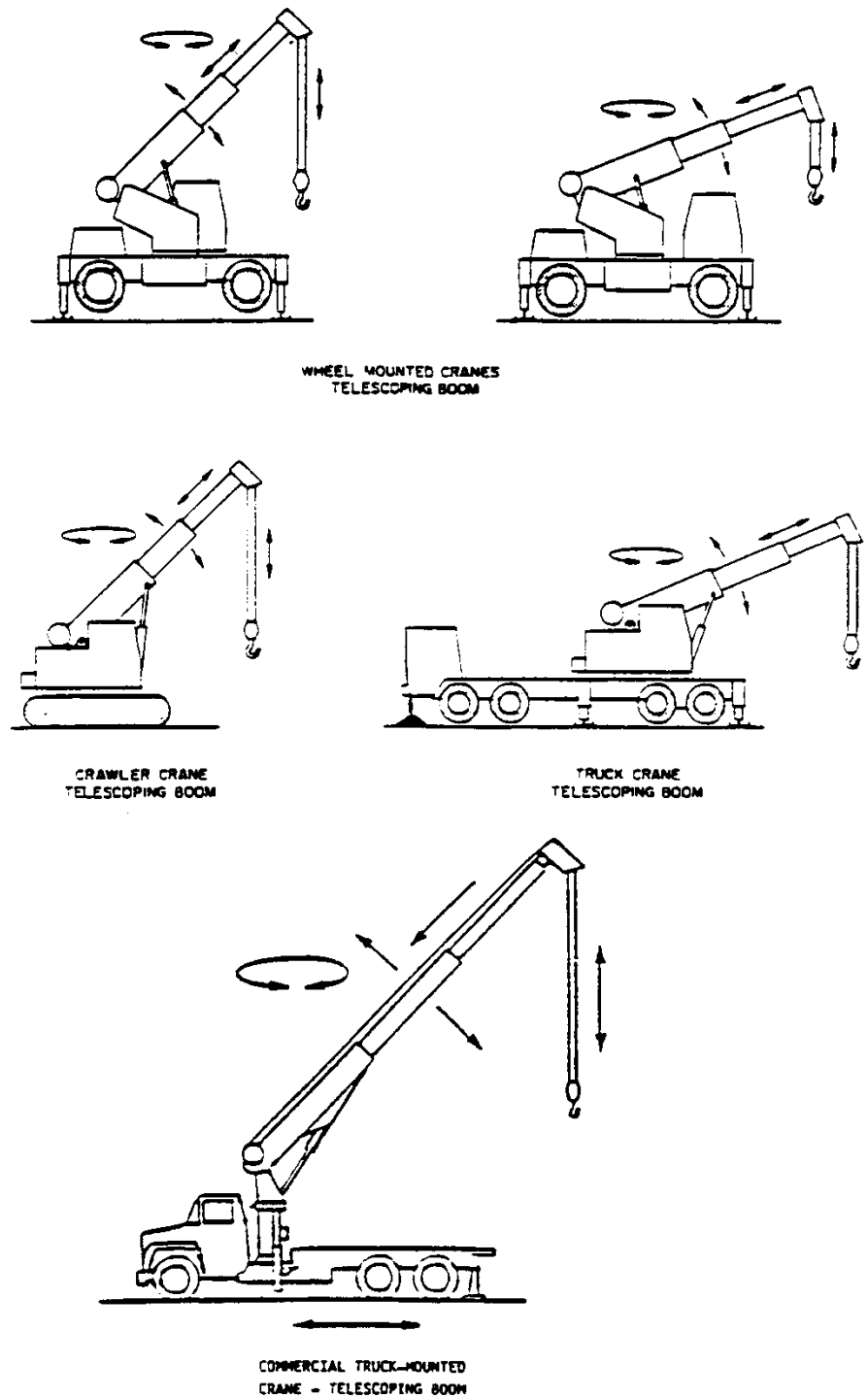
Joseph Marin, "Mechanical Behavior of Engineering Materials," Englewood, N. J.: Prentice-Hall, Inc., 1962

"Guide to Design Criteria for Metal Compression Members," Column Research Council, Cushion Mallory, Inc., Ann Arbor, Michigan, 1960

3. DEFINITIONS

3.1 STRAIN (ϵ)

Deformation of material caused by weight and applied loading, quantitatively stated as unit change from an original dimension in meters per meter (m/m) or inches per inch (in/in).



The boom may have a basic boom structure of two sections (upper and lower) between which additional sections may be added to increase its length, or may consist of a base boom from which one or more boom extensions are telescoped for additional length. These are some typical configurations.

FIGURE 1 - TYPICAL CONSTRUCTION-TYPE CRANES

3.2 STRESS (S)

The intensity of internal force accompanying strain, expressed in pascals (Pa) or pounds per square inch (psi). For purposes of this test method, stress is related to measured strain by the uniaxial stress equation:

$$S = E \cdot \varepsilon \text{ (Within the proportional limit)} \quad (\text{Eq 1})$$

where:

S = stress, Pa (psi)

E = modulus of elasticity, Pa (psi) for the material involved (see 10.5)

ε = strain gage reading, m/m (in/in)

NOTE: The simple uniaxial stress formula can be insufficiently accurate for some areas of crane structures under biaxial stress and special consideration should be given in such cases. (See 10.1.1).

3.3 Yield Point (S_y)

The stress at which a disproportionate increase in strain occurs, without a corresponding increase in stress. For purposes of this code, yield point is to be considered as the minimum yield point or yield strength specified by the appropriate standard or by manufacturer for the material used.

3.4 Critical Buckling Stress (S_{cr})

The average stress which produces an incipient buckling condition in column type members. (See 10.3.2).

3.5 Initial Reference Test Condition

The defined no stress or zero stress condition of the crane structure after "break-in" (see 8.3) as established by:

- Supporting the structure on blocking to minimize the effects of gravity; or
- The crane structure components in an unassembled state, or any alternate method that will establish the zero stress condition.

Under this condition, the initial reference reading for each gage is obtained, N_1 .

3.6 Dead Load Stress Condition

The completely assembled crane structure on the test site, in the specified position or attitude, ready to accept or pick up the specified live load. Under this condition the second reading for each gage is obtained, N_2 .

NOTE: In determining N_2 , the weight of hook, block, slings, etc., is considered as live load and should be resting on the ground or supported by a structure other than the crane.

3.7 Dead Load Stress (S_1)

The stress computed as defined in 3.2, by using the difference in the readings obtained in 3.6 and 3.5 for each gage, ($N_2 - N_1$).

3.8 Live Load Stress Condition

The completely assembled crane structure on the test site, in the specified position or attitude, supporting the specified live load. Under this condition the third reading for each gage is obtained, N_3 .

3.9 Live Load Stress (S_2)

The stress computed as defined in 3.2, by using the difference in the readings obtained in 3.8 and 3.6 for each gage, ($N_3 - N_2$).

3.10 Resultant Stress (S_r)

The maximum stress induced in the structure as a result of dead load stress (S_1) or the algebraic sum of dead load stress (S_1) and live load stress (S_2), whichever is greater.

3.10.1 Resultant Average Stress (S_{ra})

The direct compression stress in a column or the average stress computed from the several gages loaded at the section. (See 10.3.2.)

3.10.2 Resultant Maximum Stress (S_{rm})

The maximum compression stress in a column computed from the plane of buckling, as established from the several gages located at the section. (See 10.3.2.)

3.11 Loadings

The application of weights or forces of a magnitude specified under the test conditions.

4. SYMBOL NOMENCLATURE SUMMARY

DL = dead load stress, Pa (psi)

E = modulus of elasticity, Pa (psi)

G = modulus of rigidity (shear), Pa (psi)

JL = jib length, m (ft)

K = effective length factor for column

L = unsupported length of column, m (in)

Lb = length of boom, m (ft)

Lj1 = length of jibs or extensions, m (ft)

Lj2 = length of additional jibs or extensions, m (ft)

LL = live load stress, Pa (psi)

n_1 = strength margin, Class I area, ratio of yield strength to resultant or equivalent stress

n_2 = strength margin, Class II area, ratio of yield strength to resultant or equivalent stress

n_3 = strength margin (derived from an interaction relationship) in Class III areas

N_1 = gage reading at initial reference test condition (zero stress condition)

N_2 = gage reading at dead load stress condition

N_3 = gage reading at live load stress condition

r = radius of gyration of cross section, mm (in)

RR = rated radius, m (ft)

RL = rated load, kg (lb)

S = stress, Pa (psi)

S_1 = dead load stress, Pa (psi)

S_2 = live load stress, Pa (psi)

S_{cr} = computed critical buckling stress for axially loaded compression elements, Pa (psi)

SL = side load, kg (lb)

SLL = side load, left, kg (lb)

SLR = side load, right, kg (lb)

S_p = stress at effective proportional limit, defined as $S_y - S_{RC}$, Pa (psi)

S_r = resultant stress, Pa (psi)

S_{ra} = resultant average stress computed from several gages at one section, Pa (psi)

S_{RC} = maximum residual stress in compression, Pa (psi)

S_{rm} = maximum compression stress in a column computed from plane of buckling as established by several gages at one section, Pa (psi)

S_y = stress at yield point, Pa (psi)

S' = equivalent uniaxial stress, Pa (psi)

t = horizontal distance from the load center to the front pad reaction center for each boom section under consideration, m (ft)

ν = Poisson's ratio

α = boom elevation angle, degrees

β = jib offset angle, degrees

ε = strain, m/m (in/in)

ε_a = strain recorded from leg "a" of rosette

ε_b = strain recorded from leg "b" of rosette

ε_c = strain recorded from leg "c" of rosette

ε_d = strain recorded from leg "d" of rosette

ε_x = maximum principal strain

ε_y = minimum principal strain

θ = direction of principal stress, deg

μ = units of strain, 10^{-6} m/m (in/in)

ν = Poisson's ratio

σ_0 = tensile yield stress, Pa (psi)

σ_x = maximum principal stress, Pa (psi)

σ_y = minimum principal stress, Pa (psi)

T_0 = shear yield stress, Pa (psi)

5. LIMITATIONS

5.1 This method applies to load-supporting structures as differentiated from power transmitting mechanisms. It is restricted to measuring stresses under static conditions, and a general observation after overload conditions. This method does not apply to lift capacity on tires.

5.2 Personnel competent in the analysis of structures and the use of strain-measuring instruments are required to perform the tests.

6. METHOD OF LOADING

6.1 Suspended Load

The specified load suspended at the specified radius and held stationary a few inches off the ground while strain readings are taken.

NOTE: The weight of the hook, block, slings, and rigging is considered as live load and shall be included as part of the specified suspended load. Hoisting rope is not considered part of live load.

6.2 Side Load

When the test condition requires side load, this load shall be applied horizontally and normal to the plane containing the axis of superstructure rotation and the centerline of the undeflected boom. Use manufacturer's specified reeving, and with the hoist line leaving the drum from an arbitrary position, the side load shall be applied as 3% (0.03 RL) in each direction, with the boom over the end of the machine, record N_3 for each direction. (See 3.8 and note in 9.4.4.)

NOTE: Side loading is applied to simulate the dynamic effects associated with machine operation including a 9 m/s (20 mph) wind loading that can be encountered.

6.3 Deadman Load

Deadman loading may be used, but caution shall be exercised to assure accurate simulation of live load testing, especially with respect to side loads. Positioning with this system is difficult. Deadman loading is not acceptable for tests 3, 4, 6, 7, 8, and 12 in Table 1.